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DRAWINGS ATTACHED

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(54) PROCESS OF MAKING A NYLON BELT AND SAID BELT

(71) We, THE GOODYEAR TIRE & RUBBER COMPANY, a corporation organized under the laws of the State of Ohio, United States of America, of 1144 East Market Street, Akron, Ohio, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to belts and their method of preparation. More particularly, this invention relates to a method of making belts of polyurethane elastomer.

The polyurethane elastomers have received relatively widespread use and have excellent physical properties, but where the polyurethane elastomers have been used to make belts such as the positive drive belts, V-belts or transmission belts, excessive surface wear has been experienced.

Therefore, it is an object of this invention to provide a polyurethane elastomer composite driving belt which has improved wear resistance and also a lower coefficient of friction.

The objects of this invention may be achieved by forming a polyamide coating upon the polyurethane elastomer. This is achieved by coating the mold with a coating of a polyamide and then casting the polyurethane reaction mixture upon the polyamide coated mold surface and allowing it to react to obtain a shaped polyurethane elastomer having a polyamide coating bonded thereto.

The nature of this invention may be more readily understood by reference to the drawing which is a cross-sectional view through a V-belt mold with numeral 2 indicating the mold and 3 indicating the polyamide coating that has been applied to the hot mold. The polyamide coating may be added as an aqueous dispersion or as a solvent solution. In general, it is found to be

preferred to add the polyamide as a solvent dispersion in a suitable solvent such as a mixture of isopropyl alcohol and ethyl alcohol.

The polyamide coating may be applied by brushing, spraying, dipping or other appropriate application means, but in general spraying or brushing is preferred. The coat of polyamide is usually 1 to 10 mils thick with the preferred range being 2 to 6 mils.

Once the nylon coating has been applied and the water or solvent removed, then a suitable polyurethane reaction mixture is poured or cast into the cavity of the mold and allowed to set and cure to give a belt having a polyamide covering. If it is so desired the belt may contain fabric or wire reinforcement 5 which is placed within the mold after part of the polyurethane reaction mixture has been poured therein or prior to the time the reaction mixture has been poured therein. Usually it is desired to cure the finished belt at 100 to 300°F. for several hours, i.e. 0.25 to 20 hours, to more effectively utilize the mold, although it should be apparent, if so desired, that the polyurethane reaction mixture could be allowed to cure at room temperature by standing a sufficient length of time.

The polyamides useful in this invention are the condensation products of an organic diamine and an organic dicarboxylic acid or its anhydride. The nature of the organic diamines and organic dicarboxylic acids are well known and are those normally used in making the so-called molding grade nylons or barrier grade nylons as well as those used for making fabrics.

The polyamide or nylon need not be a pure condensation product of an organic diamine and an organic dicarboxylic acid, although substantially so, and suitable derivatives will suggest themselves to persons skilled in the art. A suitable formula for preparing the derivatives follows:

[Price 25p]

	Nylon resin	...	...	...	100 parts by weight
	Tributylamine	...	...	...	7 " " "
	Plasticizer such as LX-117	...	...	...	10 " " "
	Maleic anhydride	...	...	...	4 " " "
5	Sufficient low molecular weight alcohol (ethyl and isopropyl alcohols being preferred) in water (3:1) to make a solution of 10% nylon content.				

10 The nylon resin of the above formula is that produced by Belding-Corticelli Company of New York, and identified as their Type 8-1-8. This is a terpolymer of hexamethylene adipamide, hexamethylene sebacamide and caprolactam in the weight ratio of 60/20/20, 15 which has been methoxylated and thereafter treated with alkali. The tributylamine of the formula catalyzes the esterification of the maleic anhydride with the hydroxymethyl groups on the nylon to crosslink the same. 20 The LX-1117 is a plasticizer also manufactured by Belding-Corticelli Company. The alcohol is a cheap solvent. Other low-boiling organic solvents, aqueous or non-aqueous can be used. By "low-boiling" is 25 meant a solvent that will evaporate sufficiently rapidly under production conditions to be used commercially.

30 Other soluble nylons may be used. Cross-linkable nylons (e.g. methoxylated and alkylene-oxide treated nylons such as DuPont Type 6A and 6B and Type 8) which react with the polyurethane precursor are suitable.

35 The polyurethane reaction mixture useful in this invention may be made by either the prepolymer or the one-shot method. In general, the prepolymer method is preferred and the nature of the invention will be 40 illustrated specifically in regard to the use of the prepolymer method.

45 The prepolymer is preferably prepared by reacting a degassed reactive hydrogen containing material of molecular weight 700 to 7000 with the preferred range being 1000 to 3500 with an organic polyisocyanate preferably difunctional. Usually the reactive hydrogen containing material is reacted with an excess of an organic polyisocyanate with the preferred mol ratios being from 1:1.5 50 1:2.5 although as little as 1.1 mol of polyisocyanate per mol of the reactive hydrogen containing material may be utilized in some instances.

55 The prepolymer is then preferably reacted with a suitable crosslinking agent such as a monomeric glycol or an organic diamine or an alcohol amine. The ratios of the crosslinking agent is normally chosen where there will be a slight excess of isocyanate 60 over the total reactive hydrogens present with the preferred range being .1 to .9 mol of crosslinker for each mol of excess organic polyisocyanate. The reactive hydrogen con-

taining materials may be any of the well known polyether diols, the hydrocarbon diols 65 and the polyester diols. Representative examples of these are those disclosed in British Patent No. 1,015,125.

Representative of the organic polyisocyanates are those also shown in U.S. Patent No. 2,937,151, as well as hydrogenated 70 methylene diphenyl isocyanate.

The nature of the crosslinking agents are any of the well known monomeric glycols, 75 for instance, those having from 2 to 10 carbon atoms or the well known organic diamines of either the fast or slow reactive type as measured by the hot methylene chloride tests set forth in U.S. Patent No. 2,620,516. 80

The invention is further illustrated by the following representative examples of the application of this invention where the percentages and parts are by weight unless 85 otherwise indicated.

EXAMPLE I

A steel mold suitable for casting a polyurethane V-belt was cleaned by shot blasting and heated to 250°F., and then the cavity of the steel mold was given a spray coat of a mixture comprising 3.5 parts of granular crosslinkable nylon (DuPont type 809), 12.5 parts of denatured alcohol and 29.5 parts of normal propyl alcohol. When the alcohol solvent had evaporated, a polyurethane was 90 cast into the mold by pouring in a polyurethane reaction mixture formed by reacting a polyurethane prepolymer with a crosslinking agent. The polyether prepolymer was formed by reacting 500 parts of a polytetramethylene ether glycol of 990 molecular weight with 175 parts of toluene diisocyanate, the polyether having been degassed for one hour at 120°C. under 20 millimeters of vacuum prior to the addition of toluene 95 diisocyanate. The toluene diisocyanate was allowed to react with the glycol one-half hour at 120°C. with stirring and under a vacuum of 20 millimeters of mercury. Then this prepolymer was mixed with 100 parts 100 of methylene-4,4'-bis orthochloroaniline containing 5 parts of an antioxidant N-phenyl beta naphthylamine to form a polyurethane reaction mixture which was poured or cast into the mold to make a belt. The cast 105 polyurethane in the mold was allowed to stand for 16 hours at 120°C., then the 110 115

cast V-belt was removed from the mold and its coefficient of friction was determined against smooth steel and was found to be 0.32 whereas a polyurethane belt made without the nylon coating had a coefficient of friction of 0.66.

EXAMPLE II

Another belt was made using the steel mold which was coated with nylon by the procedure of Example I. This casting formulation comprised a polyurethane reaction mixture comprising 700 parts of polyethylene glycol azelate of about 2000 molecular weight and having an acid number of less than 5, 150 parts of diphenyl methane diisocyanate and 50 parts of methylene bis orthochloraniline. This prepolymer reaction mixture was poured into the steel mold and allowed to react to form a finished article having a nylon coating. The coefficient of friction was determined on this cured polyurethane having a nylon covering and was found to be 0.39, whereas the polyurethane without the nylon covering had a coefficient of friction of 0.60.

Instead of the polyesters which have been described in the above examples the prepolymer could as readily be made using a mixed ethylene propylene adipate of about 2000 molecular weight and having an acid number of less than 5 or any of the other

well-known polyesters in preparing the belt of these examples. Also, the hydrocarbon polyols obtained by the polymerization of a conjugated diene such as isoprene or butadiene alone or with a copolymer such as styrene and hydroxylation of the polymer to give the hydrocarbon glycol, may be utilized to prepare the polyurethane reaction mixture used in Examples I and II to obtain belts having the advantages of this invention.

The coefficient of friction was determined by the moving sled stationary plane procedure as provided for in ASTM Method 894-63.

WHAT WE CLAIM IS:—

1. A driving belt consisting essentially of a polyurethane elastomer core and a polyamide coating bonded to the surface thereof.

2. The driving belt of Claim 1 wherein the polyamide coating is 1 to 10 mils thick.

3. A method of making a driving belt comprising coating a mold with a polyamide and then shaping and curing a polyurethane reaction mixture in contact with said polyamide to bond the polyurethane to the polyamide.

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